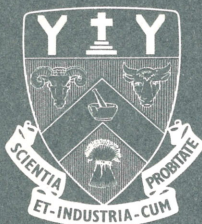


AGRICULTURAL  
ECONOMICS  
RESEARCH UNIT



Lincoln College

FLUCTUATIONS IN  
WOOL PRICES  
1870-1963

*by*

B. P. PHILPOTT

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FLUCTUATIONS IN WOOL PRICES 1870-1963

B. P. PHILPOTT

Professor of Agricultural Economics

and

Director, Agricultural Economics Research Unit

Lincoln College

(University of Canterbury)

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## THE AGRICULTURAL ECONOMICS RESEARCH UNIT

THE Unit was established in 1962 at Lincoln College with an annual grant from the Department of Scientific and Industrial Research. This general grant has been supplemented by grants from the Wool Research Organisation, the Nuffield Foundation and the New Zealand Forest Service for specific research projects.

The Unit has on hand a long-term programme of research in the fields of agricultural marketing and agricultural production, resource economics, and the relationship between agriculture and the general economy. The results of these research studies will be published as Unit reports from time to time as projects are completed. In addition, it is intended to produce other bulletins which may range from discussion papers outlining proposed studies to reprints of papers published or delivered elsewhere. All publications will be available to the public on request. For list of publications see inside back cover.

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P. Hampton, Ph.D.(Ott.), M.A.  
*Lecturer in Economics, University of Canterbury*

## P R E F A C E

The Research Unit, supported by a grant from the Wool Research Organisation, has on hand a programme of research on factors affecting wool prices. Much of this research has involved further development of work commenced in 1950 by the present author at the University of Leeds, and published in the Yorkshire Bulletin of Economic and Social Research. The results of the current research programme are now being prepared for publication in a series of Research Unit bulletins but before these are released it seemed appropriate to reissue the original Yorkshire Bulletin article which is now out of print and for which there have been many demands.

Part I of the present publication is a reprint of the original article, "Fluctuations in Wool Prices 1870-1953", as it was first published in the Yorkshire Bulletin.

In Part II, entitled "Postscript - The Results Brought Up-to-Date", the analysis given in Part I is brought up-to-date with the additional data now available.

The author is well aware of the host of imperfections, especially in the econometric methods used, in the original paper. Many of these shortcomings have been corrected in later work and any value remaining in the original paper is mainly of an historical nature.

Lincoln College,  
August 1965.

B. P. Philpott

## PART I

### FLUCTUATIONS IN WOOL PRICES, 1870-1953

(From Yorkshire Bulletin of Economic and Social Research,  
Vol. 7, no.1, March 1955)

#### I. INTRODUCTION

The object of this article is to present the results of an econometric study of the considerable movements in wool prices which have occurred since 1870, that year being the earliest for which any reasonably accurate statistical data are available.<sup>1</sup>

Throughout the original study the fundamental aim was to construct and test simple models of the wool market which do not strain the writer's scanty mathematical equipment but which were, nevertheless, sufficiently precise to be used in interpreting current wool price movements, in making tentative price forecasts and in forming economic policy in a major wool-producing country. The nature of the statistics relevant to wool production and consumption imposes further limitations on the thoroughness with which models can be constructed. These statistics are not good,

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<sup>1</sup> The bulk of the work underlying this article was completed in Leeds in 1953 and, though many alterations and additions have been made since then, it will be found substantially embodied in the writer's unpublished Thesis, "Wool Prices 1870-1950" (here-in-after referred to as "Wool Prices") lodged in the Department of Economics, University of Leeds. Professor A.J. Brown, under whose supervision the investigation was conducted, was a source of constant assistance and interest.

even by pre-war standards, and in many cases are non-existent, so that rough working approximations had often to be made and used. It was, therefore, always necessary to formulate the theory in such a way that it could be tested by those statistics which were available, if only in a rough and ready form, and this imposed necessary limits on the analytical depth which could be incorporated in the models.

In the next three sections these models will be discussed and in Sections V and VI tested by regression analysis. In the last section the implications of the results for economic policy will be discussed.

## II. ANALYSIS OF WOOL PRICE FORMATION

In the analysis of price formation we still depend for our basic theoretical conceptions on Marshall, who taught that the analysis must be modified according to the time period allowed for adjustments to take place; or, more generally, according to which variables we regard as given and which we regard as determined within the system. With the limits of the time periods decided upon, the essence of the equilibrium method lies first, in establishing the nature of the forces motivating the economic units in which we are interested and, secondly, by using the concept of the market, in setting these opposing forces equal to each other so that the conditions are found for them to be neutralised in a position of self-perpetuation. The position is characterised by the condition that supply equals demand - in the Marshallian long-run that *ex ante*

production equals ex ante consumption.

This long run analysis rightly ignores the fact that in the real world, production and consumption of the same physical items are not contemporaneous, for it assumes that stocks are constant and that all lags have "worked themselves out". In the short run, however, these lags become important and great care is needed in interpreting the terms supply and demand. Keynes' "General Theory" showed the danger of applying long-run analysis to short-run situations where the rates of flow of the commodity to be analysed may be small in relation to the size of stocks held, which may therefore be the most important influence on short run prices.

The problem of analysing wool prices is therefore best attacked by looking separately at periods of different lengths in each of which different variables assume importance. In all periods the equilibrium condition is that supply equals demand, and defining the periods virtually means defining what is meant by supply and demand in each of them.

To decide on the appropriate time periods it is necessary to consider the lags in the flow of wool from original producer to final consumer. These lags appear to conform roughly to the following pattern.<sup>1</sup>

- In year  $t$ : Wool is grown by farmers in response to prices in years  $t - 5$  to year  $t - 1$ .
- In year  $t + 1$ : Wool is sold to manufacturers and dealers and consumed or held in stock by them.
- In year  $t + 2$ : Wool is sold to final consumers in the form of wool clothing, etc.

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<sup>1</sup> These lags are imposed by the physical structure of wool production, wool textile manufacture and of transport. Empirical verification will be found in "Wool Prices".

With these lags in mind it is possible to think of two extreme periods.

(1) The Short Period

This is a period so short that the quantity of wool offered for sale by farmers and the quantity consumed by manufacturers are both independent of the price of wool at which the market settles in equilibrium. This period can be as short as we wish, but it is suggested that it can be no longer than one year. This suggestion is based on the three following facts: In the first place, farmers rarely exercise reservation demands over the sale of their wool for the whole season.<sup>1</sup> The wool producers' motto is "sell and repent, but sell". Secondly, current wool consumption by manufacturers is related to current clothing consumption; and thirdly, the price of clothing, and therefore the consumption of clothing, in so far as it is affected by the price of wool, is subject to a lag of one year arising from the clothing production period and from the practice of pricing on the basis of original cost.<sup>2</sup>

(2) The Very Long Period

This is a period so long that both the rate of wool production by farmers and the rate of wool clothing consumption by households have fully adjusted themselves to the price of wool at which the market settles in equilibrium. In view of the production lag<sup>3</sup> in wool growing, this period will be at least five years.

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<sup>1</sup> "Wool Prices", p.7.

<sup>2</sup> "Wool Prices", pp.48-54.

<sup>3</sup> "Wool Prices", p.5 and pp.35-37.



In between the short period and the very long period there is a third period which we shall call the long period.

### (3) The Long Period

This is a period too short for the rate of wool production by farmers to be adjusted to the price of wool at which the market settles in equilibrium, but long enough for the rate of wool clothing consumption by households to be so adjusted.

As the very long period demands an analysis of the supply function for wool it will not be used in this study,<sup>1</sup> but precise models must now be constructed for the long period and the short period.

## III. THE LONG RUN MODEL

In this context the definitions of supply and demand are:

Supply: Raw wool produced and sold by farmers.

Demand: Raw wool consumed, in the form of wool products,  
by final consumers.

The condition that supply equals demand thus requires that raw wool production shall be equal to final raw wool consumption.

The following symbols are used:

PW : Production of raw wool

CW : Consumption of raw wool

$p_w$  : Price of raw wool

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<sup>1</sup> Some preliminary work on the supply function will be found in "Wool Prices", pp.35-37.

Y : Total real income of the system.

S : A variable denoting the influence on production of all factors other than the price of wool, that is, influences which shift, bodily, the supply curve for wool.

We assume for the time being that all other prices are constant.

1. Assume first that wool is consumed by households in the same form in which it is produced. Then in the very long period in which the supply of wool has responded fully to the price of wool, the following demand and supply relations apply in any closed system:

$$CW = a - bp_w + cY \quad . . . . . (1)$$

$$PW = a_1 + b_1p_w + c_1S \quad . . . . . (2)$$

When all lags have worked themselves out equilibrium requires that :

$$CW = PW \quad . . . . . (3)$$

Setting (1) = (2) and solving for  $p_w$  we obtain:

$$p_w = \frac{a - a_1}{b + b_1} + \frac{c}{b + b_1} Y - \frac{c_1}{b + b_1} S \quad . . . (4)$$

Even if we had data for S as well as Y, it would not be possible with regression analysis to obtain estimates of b and  $b_1$ .

Consider now the long period in which supply adjustments have not been made to current prices. The following relations then apply:

$$CW = a - bp_w + cY \text{ as before} \quad . . . . . (5)$$

$$PW = CW \text{ as before.}$$

Then set  $CW = PW$  in (5) and solve for  $p_w$

$$p_w = \frac{a}{b} - \frac{1}{b} PW + \frac{c}{b} Y \quad . . . . . (6)$$

Separate estimates can now be secured for the values of  $b$ ,  $a$ , and  $c$ .

2. Next consider the more realistic case where wool is only one constituent in the final cost of wool products, while still restraining the analysis to the long period. Denoting by  $PC$  and  $CC$ , the production and consumption of wool clothing, a similar set of equations can be built up:

The final consumers' demand equation for clothing:

$$CC = a - bp_c + cY \quad . . . . . (7)$$

The manufacturers' demand function for raw wool which, owing to the possibilities of substituting other raw materials for wool, is elastic with respect to the price of wool:

$$CW = a_1 - b_1 p_w + c_1 PC \quad . . . . . (8)$$

The relationship between the price of clothing and the price of wool:

$$p_c = a_2 + b_3 p_w \quad . . . . . (9)$$

Over the long period,  $PC = CC$ , and substituting (9) for  $p_c$  in (7), and (7) for  $PC$  in (8), we obtain:

$$CW = (a_1 + c_1 a - c_1 b a_2) - b_1 p_w - c_1 b b_3 p_w + c_1 c Y \quad (10)$$

Calling the first bracketed group of terms  $a_3$ , (10) becomes:

$$CW = a_3 - p_w (b_1 + c_1 b b_3) + c_1 c Y \quad . . . (11)$$

But in this period  $CW = PW$ . So substituting in (11) and solving for  $p_w$

$$p_w = \frac{a_3}{b_1 + c_1 b b_3} - \frac{1}{b_1 + c_1 b b_3} PW + \frac{c_1 c}{b_1 + c_1 b b_3} Y \quad (12)$$

So far we have implicitly assumed that all relationships - demand functions, etc., - were linear. The coefficients entering into (12), which have been expressed in linear terms, are related to the following elasticities when due account is taken of the proportional nature of elasticities.<sup>1</sup>

- b : Price elasticity of demand for wool clothing.
- $b_1$ : Manufacturers' elasticity of demand for wool.
- $b_3$ : Elasticity of the relationship between wool prices and wool clothing prices. In general this will depend on the proportion of total clothing price represented by the cost of wool.
- $c_1$ : Unity, since, in the long period wool consumption is proportionate to clothing production, apart from the substitution of other materials.

If the variables are expressed in logarithms, the coefficient of PW in (6) is the inverse of the total price elasticity of demand for wool and the coefficient of Y is the ratio of the income elasticity to the price elasticity.

Equation (12) is an equation of comparative statics. It forecasts the changes which can be expected in the price of wool between two periods, as a result of changes in production and income, when all adjustments on the consumption side are made. The change referred to is a once-for-all change, and thereafter the system settles down into long period equilibrium. In the real world in which we want

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<sup>1</sup> Similar results to these were secured by F.B. Horner, "The Pre-war Demand for Wool", Economic Record, May, 1952. His results were not, however, in a form suitable for testing with time series of income, prices and production of wool.

to use the model, all the variables are continuously changing, either autonomously, or as part of a movement towards a continuously changing equilibrium position. To test the model we must therefore relate the average price and the average production and income over periods of years sufficient for all the demand adjustments to have worked themselves out; but not so long as to run the risk of the supply relation entering. Five-year periods should be sufficient for this and so, in testing the model, five-year moving averages are used.

#### IV. THE SHORT RUN MODEL

The long run model just developed would, in a world of perfect knowledge and foresight, form the basis of action for all marketeers and there would be no reason for wool prices to differ from their true equilibrium values except by an amount necessary to cover carrying charges and interest. It is the task of a useful short run model to describe (in a way suitable for testing with the data available) how the market feels its way to long run equilibrium in a world in which not only is there no perfect knowledge and foresight, but, in addition, all the independent variables - income, other prices, wool production, etc., - do not increase or decrease smoothly but often exhibit continual fluctuation.

The short run market we have defined as one in which the rate at which manufacturers are consuming wool is independent of the price (of wool) which we are hoping to explain. We are not concerned with the reasons for changes in mill consumption. In part that was the concern

of the previous section, but it would require, in addition, a careful discussion of inventory policies of manufacturers, traders and even of consumers of clothing, and of changes in foreign trade in wool products. When allowance is made for these factors, wool consumption (in so far as it is dependent on current wool clothing consumption) is more likely to be affected by the wool prices of the previous period, as a result of the lag before the product reaches final consumers.<sup>1</sup>

The persons making up the market are all those who hold wool, a group including, and extending from, manufacturers who consume it up to, but excluding, farmers who produce it. Supply for the period then equals wool offered for sale by farmers during the period, plus any stocks possessed by the market at the beginning of the period. The amount demanded by definition equals amount supplied as someone in the market must hold or consume the wool available. We are therefore under no duty to analyse the forces behind supply, but it is necessary to investigate the factors inducing people to hold wool.

For simplicity assume that no member of the market experiences any difficulty in financing his activities and that no violent movements are occurring in the prices of

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<sup>1</sup> This argument would require modification if manufacturers' and retailers' prices were always set on a complete replacement cost basis (rather than an original cost basis) or if manufacturers entertained definite ideas as to consumers' price elasticity of demand for clothing and as to the likely future course of disposable incomes.



other commodities. A member of our market can be a manufacturer, wool merchant, or speculator, or he may even be a person who combines all these functions. In any event the motive for holding wool at any time will be different for each of them.

Each member will require, in conjunction with his existing stocks, a certain quantity of new wool to sustain an expected rate of consumption until new supplies are available. If we ignore, for the moment, expectations as to the future, it does not seem likely that these requirements would be very elastic with respect to price. Manufacturers probably have some idea of normal price in relation to the other costs of manufacturing,<sup>1</sup> all of which must be ultimately passed on to retailers, if not to consumers. However, wool accounts for only a small proportion of final cost of clothing, and this factor would operate only within broad limits within which it is likely that greater losses would arise through a failure to keep machine activity steady.

In the aggregate it is unlikely that these requirements for wool consumption would equal aggregate supply, period by period, and violent fluctuations in price could be expected to result from the confrontation of an inelastic moving demand curve and vertical supply curve. But we have ignored expectations as to the future of prices and it

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<sup>1</sup> Observers in the trade have suggested that some manufacturers in the United Kingdom take as their guide to "normal price" the weekly wages of the wool textile workers. It is contended that the consumption of wool suits can be expected to rise or fall when wool suit prices fall or rise beyond some defined multiple of this weekly wage rate. Two limiting values to "normal price" are thus provided for wool suits and, by implication, for raw wool.

is suggested that these form the basis for another motive for holding wool, a motive which now imparts some elasticity to the market demand curve. Whatever a man's requirements of wool for consumption may be, he is unlikely to exercise this demand if he feels confident that supplies will be cheaper at a not too distant date; or alternatively, he will be disposed to add to his normal requirements an amount of wool sufficient to carry him over a period when supplies are expected to be dearer.

For any one person in the market to form a view about the future is, even with the fullest acquaintance with the facts about the present, a difficult operation, which manufacturers prefer as far as possible to leave to the specialised skill of wool merchants and speculators. Nevertheless, they must take some view of the market and, apart from current gossip and hunches, manufacturers probably rely on their own present rate of consumption and the state of their own order books as the best indication of the state of affairs with respect to consumption in the market at large, both now and in the future. As far as supply is concerned, estimates of expected wool clips and market offerings were periodically made and published before 1939 and would provide a guide to future market supply. Speculators and merchants may be placed in a better position to take an overall view of the market, but it seems doubtful whether they would possess any better information than that detailed above, on which individual manufacturers rely, and this they would acquire second-hand.

Let us now look at two specific situations where these forces are at work.

In the first we conceive of a very short period in which the supply of wool is not likely to be augmented for some considerable time, i.e. it is properly defined as stocks. This in fact would be the situation if the current wool clip were all marketed in one month each year, with no possibility of fresh supplies until the same month of the following year. Some elements of this imaginary situation are in fact presented by the state of affairs as it exists in the wool market in July of each year. By July the disposal of the current wool clip is completed and there is no possibility of replenishing the stock of wool then in existence for six months, i.e. until the opening of the new season.

In this situation the extent to which future supplies (from new production) are likely to influence prices will be slight in relation to the effect of changes in current consumption, for the reason that any likely change in supply is in the relatively distant future, and the trade has learnt by experience that consumption can suffer many vicissitudes in the interim. Fluctuations in the rate of wool production are never great as between adjacent years, but in any case ample resources and a steady nerve are required to speculate on the course of prices over two or three years when gains may be made in the immediate future.

Given, then, the stocks of wool, the price at which all persons in the market, together, are prepared to hold those stocks will depend mainly on present rate of consumption. As the commencement of the new marketing season approaches, considerations relevant to supply will begin to assume greater importance and this situation shades into the next which we discuss.

This is the situation which would be presented if the marketing of raw wool were to take place continuously over the whole year so that the supply of wool is now a flow of so much per month. Looking at the period as a whole the demand still equals supply in the sense that aggregate amount marketed equals aggregate amount consumed plus aggregate amount taken into stocks, but because new supply is continuously replenishing the market it becomes just as important, day by day, in influencing prices as are fluctuations in consumption. At the beginning of the period the market's ideas of consumption and supply to be expected will both be conjectures based on present consumption, length of order books, and estimates of clips and, as the period unfolds itself, the conjectures will be amended and so will prices.

In comparing any two annual periods we may then say:

(1) Given the annual rate of consumption, a higher annual supply will lower annual average price, since it gives ground for expectation that prices will be lower in the future.

(2) Given the annual rate of supply, a higher annual rate of consumption will raise the annual average price, since it raises the demand for working stocks, and in so far as it is expected to continue, the expected future price.

In some senses the wool market presents elements of both stock and flow situations; the former for a few months from about June to September when the primary markets are inactive, and the latter over the period September to June when new wool is being continually

offered for sale.

As most of our available data are annual totals, for production and consumption, and as we have little information available on stocks, the flow model is the only one which can be tested.

Accordingly the model in algebraic terms is written -

$$p_w = a + bCW - cSW$$

where  $p_w$  is the price of wool - annual or seasonal average.

CW is the mill consumption of wool - annual or seasonal.

SW is the supply of wool - annual or seasonal.

## V. THE LONG RUN PRICE

### (1) Data Used<sup>1</sup>

To test the long period model we need series for world income and world supply of wool. As the model was developed on the assumption of constant other prices it is also necessary to use, as the dependent variate, wool prices deflated by some indicator of all other prices.

As an indicator of world income there are two choices open to us. The first is to aggregate the figures of real national product given for many countries by Colin Clark<sup>2</sup> in international units. Unfortunately it is not possible

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<sup>1</sup> Many of the series used in the regression calculations which follow required the elaborate investigation of a multitude of sources for their construction. For the sake of brevity the details are omitted here, but see "Wool Prices".

<sup>2</sup> "Conditions of Economic Progress," 2nd Edition, 1951.

to obtain these figures for the years preceding 1920 or those following 1947. The other method is to use the well known League of Nations' World Index of Industrial Production,<sup>1</sup> which provides a tolerably good index of world income, on the assumption that incomes arising from secondary and tertiary activity are linked, in a determinate way, with industrial income. It is possible to believe that such a relation does exist. In a recent article Professor W.A. Lewis<sup>2</sup> shows that -

- (a) The production of food and the potential production of raw materials can be plausibly regarded as growing at a steady percentage rate since 1870.
- (b) That the actual raw material output (as distinct from potential) is determined directly by the level of industrial production and the available capacity.
- (c) That the prices of food and raw materials are determined by the supply of food and raw materials and the index of industrial production.

There is in fact a close linear<sup>3</sup> relation between the index of world industrial production and an index of world real income in international units using Colin Clark's

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<sup>1</sup> Published in "Industrialisation and Foreign Trade", F. Hilgerdt. League of Nations, 1945.

<sup>2</sup> "World Production Prices & Trade", Manchester School of Economic & Social Studies, May, 1952.

<sup>3</sup> "Wool Prices", p.68 et seq.



figures, and so in the following regression calculations, for periods not covered by the real income index, the index of world industrial production has been used instead. Using the relationship mentioned above it turns out that for a 1% variation in the index of world industrial production we may expect world income to change by 0.45%.

The figures for wool supply consist of production in the main producing countries covering approximately 90% of world apparel wool production. To this figure is added the disposals from, or subtracted the additions to, the two stockpiling ventures: B.A.W.R.A. in 1920-24, and U.K. Dominion Wool Disposals in 1946-50.

## (2) Regression Equations

In Table I are given the results for ten regression analyses using the long run model, but with variations in the period, the type of price deflator used and in the indicator of world income used. In the case of the last two equations a fourth variate has been added, viz. an index of deflated cotton prices serving as an indicator of the prices of the principal substitute fibres. The addition of this variate results in a considerable improvement in the multiple correlation coefficient.

Little change results in the coefficients of regression No.10 when the variates are put in the form of first differences. Using the symbol  $\Delta$  to denote first differences, the result is:

$$\Delta \left\{ \begin{array}{l} \text{price of wool} \\ \div \\ \text{average of U.K. and U.S.A.} \\ \text{cost of living indices} \end{array} \right\} = 0.7947 \Delta \text{Index of industrial production (with one year lead).} \\ -2.1630 \Delta \text{Index of wool supply.} \\ 0.7827 \Delta \text{Price of cotton } \div \text{average of U.K. and U.S.A. cost of living indices.} \\ -0.8900$$

The data used in regression No.10 are given in Table III in the Statistical Appendix.

### (3) Validity of the Coefficients

Taking, in the manner indicated in Section III, the interpretations shown below for the coefficients in the regression equations, we then obtain estimates for income and price elasticity of demand for wool shown in the last column of Table I:

$$\begin{aligned} \text{Coefficient of supply} &= \frac{1}{\text{Price elasticity}} \\ \text{Coefficient of Income} &= \frac{\text{Income elasticity}^1}{\text{Price elasticity}} \end{aligned}$$

The income elasticity ranges from 0.68 to 0.98 with most of the estimates around 0.85. The price elasticity in the regression analyses which include years 1872-1911 is very much higher (-0.67 to -1.0) than for the periods 1911-1936 and 1911-1951 for which the estimates are around -0.45.

<sup>1</sup> Using the relationship (discussed above) between world income and world industrial production the income elasticity can be calculated for periods in which industrial production is used as an index of income as follows:

$$\text{Income elasticity} = \text{price elasticity} \times \frac{\text{Coefficient of index of industrial production}}{0.45}$$

TABLE I - LONG PERIOD REGRESSION EQUATIONS

<u>No.</u>	<u>Period</u>	<u>Price deflator used</u>	<u>Coefficients and Constant</u>	<u>Variables: Log of 5-yr moving average of Indexes</u>	<u>Multiple correlation coefficient</u>	<u>Elasticities</u>
(1)	1872-1936	Gold price of world manufactures	0.4924 -1.4896 3.9741	Industrial production Wool supply	0.8439	YE = 0.73 PE = -0.67
(2)	1872-1936	Average world gold price of food and manufactures	0.5330 -1.3903 3.7154	Industrial production Wool supply	0.8559	YE = 0.85 PE = -0.72
(3)	1911-1936	Ditto	1.0205 -2.7820 5.5322	Industrial production Wool supply	0.9822	YE = 0.82 PE = -0.36
(4)	1911-1936	Weighted average of world gold prices of food and manufactures	1.8056 -3.2691 4.9755	World income in international units* Wool supply	0.9191	YE = 0.68 PE = -0.31
(5)	1872-1911	Average world gold price of food and manufactures	0.4435 -1.0064 3.1619	Industrial production Wool supply	0.8680	YE = 0.98 PE = -1.00
(6)	1911-1951	Average of cost of living index for U.K. and U.S.A.	1.8814 -4.3368 7.0269	Industrial production Wool supply	0.8466	YE = 0.96 PE = -0.23
(7)	1911-1951	Average of U.K. and U.S.A. wholesale price indices	1.3202 -3.2497 5.9422	Industrial production (with 1 year lead) Wool supply	0.8657	YE = 0.91 PE = -0.31

\* This index, derived from statistics for the principal countries, is more variable than the index of world income in terms of which all the above income-elasticities are expressed, the regression coefficient of the latter on the former being 0.83.

TABLE I (Cont'd)

(8)	1911-1951	Average of U.K. and	1.7087	Industrial production	0.8608	YE = 0.95
		U.S.A. cost of	-4.0226	Wool supply		PE = -0.25
		living indices	6.7164			
(9)	1911-1951	Average of U.K. and	0.6300	Industrial production	0.9852	YE = 0.83
		U.S.A. wholesale		(with 1 year lead)		
		price indices	-1.6911	Wool supply		PE = -0.59
			0.6953	U.K. cotton prices ÷ average of U.K. and U.S.A. wholesale price indices		
			2.7334			
(10)	1920-1951	Average of U.K. and	0.7169	Industrial production	0.9969	YE = 0.86
		U.S.A. cost of		(with 1 year lead)		
		living indices	-1.8452	Wool supply		PE = -0.54
			0.7715	Price of cotton ÷ average of U.K. and U.S.A. cost of living indices		
			2.7163			

In the column headed "Elasticities" the expression "YE" denotes income elasticity and "PE" denotes price elasticity.

For regression equations (1) to (5) the variates were expressed as index numbers: Price on base 1929=100; industrial production on base 1937=100; supply of wool on base 1937=100. For regression equations (6) to (10) index numbers on base 1934-38=100 were used.

In all cases where United Kingdom and United States price indices were averaged, the sterling equivalent of the United States prices were used.

Statistical details of the variates used in regression 10 will be found in the statistical appendix to this article. Details for regressions (1)-(5) will be found in "Wool Prices".

It is possible to substantiate somewhat the validity of these estimates by comparing them with the results secured by different methods. It will be recalled from Section III that the total price elasticity of demand for wool equalled:  $b_1 + c_1 b b_3$ . Independent estimates of each of these magnitudes, as well as of the income elasticity, is possible and, although this is not the place to set out the full details of the calculations, an indication of the results can be given.<sup>1</sup>

First, estimates of the income elasticity of demand for clothing can be secured from budget studies for all clothing for Britain, Australia, Japan, Netherlands and U.S.A. Then for the world as a whole the budget method can be used by calculating the regression, in any one period, of wool available per capita in each country or real income per capita in international units. Then for both the income and price elasticity, there is available sufficient information to estimate time series demand functions for all wool clothing for Britain, U.S.A. and New Zealand.

The results of this work suggest that the income elasticity for wool clothing is somewhere between 0.7 and 1.0, while the price elasticity, i.e.  $b$ , is around -0.55.

As far as  $b_3$  is concerned, i.e. the elasticity of wool clothing prices with respect to wool prices, an estimate is only possible for Britain. This is secured by a careful year by year comparison of the prices of raw wool, of cloth and of finished clothing, the latter two prices being suitably lagged. The coefficient  $b_3$  depends on the proportion of

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<sup>1</sup> Details will be found in "Wool Prices", Chapter IV.

final clothing cost represented by the cost of wool and also on the profit margins secured and the pricing system used by manufacturers and retailers. In 1939 the proportion referred to equalled approximately 0.10 and the effect of the other factors was to give a value for  $b_3$  equal to approximately 0.20.

It remains to estimate  $b_1$ , the manufacturers' price elasticity of demand for wool. It is extremely difficult to get accurate data of the proportions of wool and other fibres used by manufacturers, but regression equations, using what rough data there are, indicate for the world as a whole an elasticity of substitution, with respect to prices, between wool and cotton of -0.3. The same figure is secured using time series for U.S.A., for which country alone there are accurate data.

If these estimates are correct then the total price elasticity of demand would equal:

$$-0.3 + (-0.55 \times 0.2) = -0.41$$

which, like the income elasticity, is very close to the values secured in the long run regression equations.

A further check on the values of the coefficient can be secured by taking account of the coefficient of cotton prices in regression No.10. Now if cotton prices were explicitly introduced into the long run model (as an indicator of wool substitute prices) then the mill consumption equation would be altered to read:

$$CW = a_1 - b_1 p_w + c_2 p_c + c_1 PC \quad . . . . . (8a)$$

(where  $p_c$  represents the price of cotton and  $c_2$  represents the effect on wool consumption of a change in  $p_c$  given  $p_w$ )



and with no change in the other long run equations, the final equation would read:

$$p_w = \frac{a_3}{b_1 + c_1 b b_3} + \frac{c_1 c}{b_1 + c_1 b b_3} Y - \frac{1}{b_1 + c_1 b b_3} p_w \dots (12a)$$

$$+ \frac{c_2}{b_1 + c_1 b b_3} p_c$$

This is the same as equation (12) except for the addition of the last term.

In regression equation No.10 the coefficient of  $p_c$  is 0.7715 and the price elasticity of demand

$$= - \frac{1}{1.8452} = -0.54$$

So  $c_2 = 0.7715 \times (\text{price elasticity of demand for wool, i.e. } -0.54)$   
 $= 0.40$

Now it seems plausible that  $-b_1$  should  $= c_2$  (i.e. price elasticity of demand for wool with respect to substitute fibres equals price elasticity of demand of substitute fibres with respect to wool), and in fact an estimate of  $b_1$  can be secured from the following equations:

$$\begin{aligned} \text{Price elasticity} &= b_1 + c_1 b b_3 \\ &= -0.54 \end{aligned}$$

$$b = -0.55$$

$$b_3 = 0.2$$

$$c_1 = 1.0$$

$$\therefore b_1 = 0.43$$

## VI. THE SHORT RUN PRICE

### (1) The Data

The model developed for the short run market is:

$$\text{Log } p_w = a + b \log CW - c \log SW$$

The construction of an index of wool supply presents little difficulty. To the figures of production and changes in official stockpiles as used before, there is added the change in the quantity of wool carried over from one season's end to another. In the first regressions no addition was made for stocks held by manufacturers, etc., at the beginning of the season, though an allowance was made for this later and reference to it will be made in due course.

The construction of an index of wool consumption presented great difficulty. Except for the U.S.A. there were virtually no figures of pre-war wool consumption available. As an imperfect substitute an index of wool textile activity was constructed - for most countries, except Britain - from production indices, and for Britain from monthly reports of wool textile employment published by the Ministry of Labour. This method when tested against Census of Production reports yields a very satisfactory index of activity for Britain,<sup>1</sup> though it must be remembered that the whole idea of using wool textile production as an indicator of consumption suffers from the defect that it takes no account of the substitution, in consumption, of other fibres for wool.<sup>2</sup>

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<sup>1</sup> For a full description of this index see "Wool Prices", Chapter III, and also "Wool Textile Activity and Wool Prices" in Yorkshire Bulletin, January, 1953.

<sup>2</sup> In the case of Britain it is possible to reach fairly close estimates of wool consumption because there are figures of available rags and shoddy which constitute a very large part of non-wool fibre consumption in the woollen industry.

As in the long run model the price of wool was deflated to take account of changes in other prices or in the value of money. This time the deflator used was the Sauerbeck index covering, as it does, raw material and food prices.

## (2) The Regressions

Table II gives some of the main results of regression analyses using these data and some notes are called for on each of these results.

In regression No.1 stocks were not included in supply. Regressions No.2 and 3 represent separate analyses for Merino and Crossbred using the figures of supply relevant to each, but again without addition of trade stocks.

For regression No.4 estimates of trade stocks were calculated and added to supply. Too great an error is involved in estimating trade stocks for countries other than the United States and Britain, but for these two countries we can place sufficient confidence in the estimates of wool consumption to use those figures in conjunction with the quantity of wool available year by year to estimate trade stocks at the end of the year. Trade stocks for these two important countries have to serve therefore as an indicator of trade stocks in all wool consuming countries. In this regression, No.4, the deflator was incorporated as a third independent variate with money wool prices the dependent variate, and considerable improvement in the correlation coefficient is achieved as the result of these two procedures.

Regressions No.5 and No.6 are the result of an attempt to take account of the different effects on average price of equal proportionate changes in Merino and Crossbred supply. In regression No.5 Merino supply and Crossbred supply (both

including trade stocks) are separately incorporated as variates. A weighted index of both Merino and Crossbred supply is then calculated in which the weights are proportional to the influence, shown by regression 5, of each on the average price. This weighted index is then used in regression No.6.

Regressions No. 2, 3, 5 and 6 are useful in confirming statistically what appears to be common practice in the wool trade in respect to substitution of coarser for finer wools. Speaking generally fine wools are preferred by the ultimate wearer of clothing but when the price of Merino becomes unduly high manufacturers are inclined to substitute Crossbred for it, instead of raising prices of cloth as much as they would otherwise have to. The reverse process takes place when prices of Merino are low. If, therefore, there is an equal increase in the supply of Merino and Crossbred we would expect some displacement of Crossbred in consumption by the cheapened Merino, even though it may perhaps not be cheapened relatively to Crossbred. The Crossbred thus displaced can only be absorbed in due course by an extension of aggregate wool consumption. It appears that while small quantities of Merino can be used to advantage to improve the quality of many Crossbred grades of yarn, the same cannot be said of Crossbred, the only inducement to substitution of Crossbred for Merino lying in the necessity on occasions to lower the total cost of the cloth, the quality of which does not improve in the process. In view of these considerations we should expect Merino to be much more elastic in demand in the long run and also in the short run in so far as the trade is similarly influenced. The relative magnitudes of the coefficients of

TABLE II - SHORT PERIOD REGRESSION EQUATIONS

No.	Period	Price series used	Coefficients and constant of equation	Variables Log of Index Numbers	Correlation Coefficient
(1)	1920-38 1947-49	$p_w$ (averages of 64's and 46's ÷ Sauerbeck	1.7610	Wool textile activity	0.9090
			1.1922	Wool supply	
			2.3013		
(2)	1920-38 1947-49	Price of 64's Merino ÷ Sauerbeck	1.3610	Wool textile activity	0.8677
			-1.0204	Supply of Merino wool	
			2.2423		
(3)	1920-38 1947-49	Price of 46's Crossbred ÷ Sauerbeck	1.7507	Wool textile activity	0.8118
			-1.7306	Supply of Crossbred wool	
			3.5350		
(4)	1920-38 1947-49	$p_w$ (average of 64's and 46's)	1.8796	Wool textile activity	0.9585
			-0.9100	Wool supply incl. U.K. & USA trade stocks at Decr. 31 (mid-season)	
			1.1565	Sauerbeck index	
			-2.1909		
(5)	1920-38 1947-49	$p_w$ (average of 64's and 46's ÷ Sauerbeck	1.8103	Wool textile activity	0.9385
			-0.3042	Supply, incl. stocks of Merino wool	
			-1.1372	Supply, incl. stocks of Crossbred wool	
			2.6079		

TABLE II (Cont'd)

(6)	1920-38 1947-49	$p_w$ (average of 64's and 46's)	1.9944	Wool textile activity	0.9738
			-1.2742	Weighted index of supply, incl. stocks, of Merino & Crossbred. Weights in proportion to coefficients of Merino and Crossbred in regression No. 5	
			1.1609	Sauerbeck Index	
			1.6866		
(7)	1920-21- 1937-38 1947-48- 1952-53	$p_w$ Seasonal average (Weighted average of 64's and 50's)	1.5779	Seasonal wool textile activity	0.9798
			-0.9947	Wool supply, incl. U.K. and U.S.A. stocks	
			1.0697	Raw material prices on seasonal basis	
			-1.3175		

See Statistical Appendix for details of the variates used in regression No. 7.

For regressions No. (1) - (6) the base of the indices used was: Price 1929=100; Activity & Supply 1937=100. For regression No. (7) the base of indices used was 1934/38=100 for all variates.



Merino and Crossbred supply in regression No.5 confirm these expectations. This general thesis is also confirmed by regressions No.2 and 5 - for at given levels of supply a given change in the level of activity affects Crossbred prices more than Merino prices.

### (3) Interpretation of the Coefficients

Consider first the coefficients of activity and supply. In each of the regressions in Table II the coefficient of activity (indicating wool consumption) exceeds the coefficient of wool supply. This would appear to confirm one of the implications of our short period hypothesis, viz. that the former coefficient should be larger inasmuch as changes in supply influence only the expected future price, while changes in wool consumption influence the demand for working stocks as well. Moreover, wool consumption varied much more than supply over the period covered, and, except for a slow rise in the rate of wool production in earlier years, the main fluctuations in supply were attributable to liquidations of carry-over and of trade stocks or to unusual climatic conditions in producing countries. It is possible, then, that any change in the level of supply is less likely to be extrapolated into the future than a corresponding change in consumption. On these grounds again we should expect a large coefficient for wool consumption.

Next consider the coefficient of the Sauerbeck Index in those regressions where it has been included as a separate variate, using money wool prices. The Sauerbeck Index was included in these regressions to eliminate the effect of changes in the general price level of all raw materials, arising (as one might say with a rather crude version of

the quantity theory of money in mind) from changes in the quantity of money supplied to support that price level. Thus given that quantity, the only reasons for a change in wool prices lie in a change in wool consumption, in wool supply, or in expectations about the future of these variables. Given the supply and consumption of all raw materials (including wool) a change in the quantity of money would change the price of wool *pari passu* with the change in all raw material prices. A coefficient for the Sauerbeck Index in the region of 1 suggests that *prima facie* the above interpretation is not unreasonable.

On closer inspection, however, serious doubts can be cast on this simple interpretation, if only because of the vagueness of the term "quantity of money". Modern monetary theory, confirmed by empirical analysis, suggests that it is possible to conceive of changes in the rate of investment (including investment in raw material stocks) occurring without any increase in the total quantity of money, but financed by the transfer of money from idle to active stocks.

Now while we may allow that the ultimate limit to any change in general raw material prices is set by the quantity of money, within the limit fluctuations can occur which are unrelated directly to any change in that quantity. Thus in a period of depression, given the rate of supply and consumption of all raw materials, including wool, a rise in the quantity of money is not by itself a sufficient condition for a rise in raw material prices which may not respond if supply and consumption conditions are adverse. On the other hand, raw material prices may rise in the absence of changes in the supply of money if the same conditions become favourable. Similarly in a boom the

price of raw materials can fall, even though there be no fall in the quantity of money, if supply and consumption conditions become unfavourable.

If, then, the Sauerbeck Index can fluctuate for reasons in no way connected with changes in the quantity of money the most probable explanation of its influence on wool prices is that for any given conditions of consumption and supply of raw materials a change in Sauerbeck reflects a shift in expectations about the future and that this shift is shared by wool traders either through the general influence of "business conditions" or because the trend of general raw material prices is taken specifically as an indicator of how things are likely to move with wool prices. This would especially influence those important traders on the fringe of the market to whom wool may be only one of the many commodities in which they may hold their capital.

Moreover it has become increasingly obvious in the wool trade since 1918 that the losses and profits arising from correct judgment of future general price levels are often larger than those arising from pure manufacturing margins, and the trade has obviously found it necessary to supplement its views about future supply and consumption of wool with a view about the future value of money in terms of raw materials in general.

On all counts, then, we are brought back to the view that in the short period the most important influences on the price of a durable commodity like wool are fundamentally connected with the state of expectations about the future. In so far as expectations are influenced by present conditions, stabilization of the latter should promote stabilization of prices.

## VII. GENERAL CONCLUSIONS ON FLUCTUATIONS IN WOOL PRICES

The foregoing results can be used to interpret some of the more violent booms and slumps which have occurred in the history of wool prices and to assist in the formation of an economic policy designed to cope with such movements in the future. Before doing this it may be desirable to sum up our conclusions so far and in particular to examine the results for any clues as to likely sources of endogenous price fluctuation in the system.

The long run price is determined by the equation:

$$p_{wt} = \frac{a}{b} + \frac{c}{b} Y_t - \frac{1}{b} p_{wt} \quad . . . . . (6)$$

The supply function (which has not been discussed in this article) appears to be of the form:

$$p_{wt} = a_1 + b_1 p_{wt-5} + T_t \quad . . . . . (13)$$

Where  $T$  denotes a trend, i.e. an annual shift to the right in the supply curve.

Then setting  $p_{w1}$  in equation (6) equal to equation (13) we get:

$$p_{wt} = \left( a - \frac{a_1}{b} \right) + \frac{c}{b} Y_t - \frac{T_t}{b} - \frac{b_1}{b} p_{wt-5} \quad (14)$$

This difference equation expresses the fact that, starting from an equilibrium situation where  $p_{wt} = p_{wt-5}$ , in order that  $p_w$  in the future, say in year  $t + 5$  should still be unchanged, it is necessary that:

$$cY_{t+5} = T_{t+5}$$

That is to say the demand curve must shift at the same rate and direction as the supply curve. If, however, any divergence should occur between the rates or directions of shift of the demand and supply curves, then not only will

the price show an upward or downward trend over time, but fluctuations around this trend may occur by virtue of the last term of equation (14). For this equation, when the first, second and third terms are omitted, is in the same form as the equation underlying the Cobweb Theorem, viz:

$$p_{wt} = a - \frac{b_1}{b} p_{wt-5}$$

Such fluctuations will be explosive or damped according as  $b_1$  is greater or less than  $b$ , i.e. according as the slope of the supply curve is greater or less than the slope of the demand curve. Even in the absence of an accurate estimate of the parameters of the supply function we can be pretty sure that some "cobweb" fluctuation (even if damped) has occurred, and will continue to occur, in addition to such fluctuation as arose from unequal shifts in the supply and demand curves.

Turning now to the short period model, we recall that it was regarded as describing the process by which the market felt its way towards a continuously moving long run equilibrium position.<sup>1</sup> We must ask then whether the price path traced by this process is likely to be oscillatory in nature. The simplest way of answering this question is to compare the actual seasonal average prices with a hypothetical "seasonal long period equilibrium price". Such an equilibrium price can be calculated from the coefficients of long period regression No.10, using annual (not 5-year average) values for supply and industrial production.

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<sup>1</sup> In this sense our short period market performs, over a period of time, the process of recontract, which Edgeworth postulated as being necessary for a day-to-day market to achieve equilibrium.

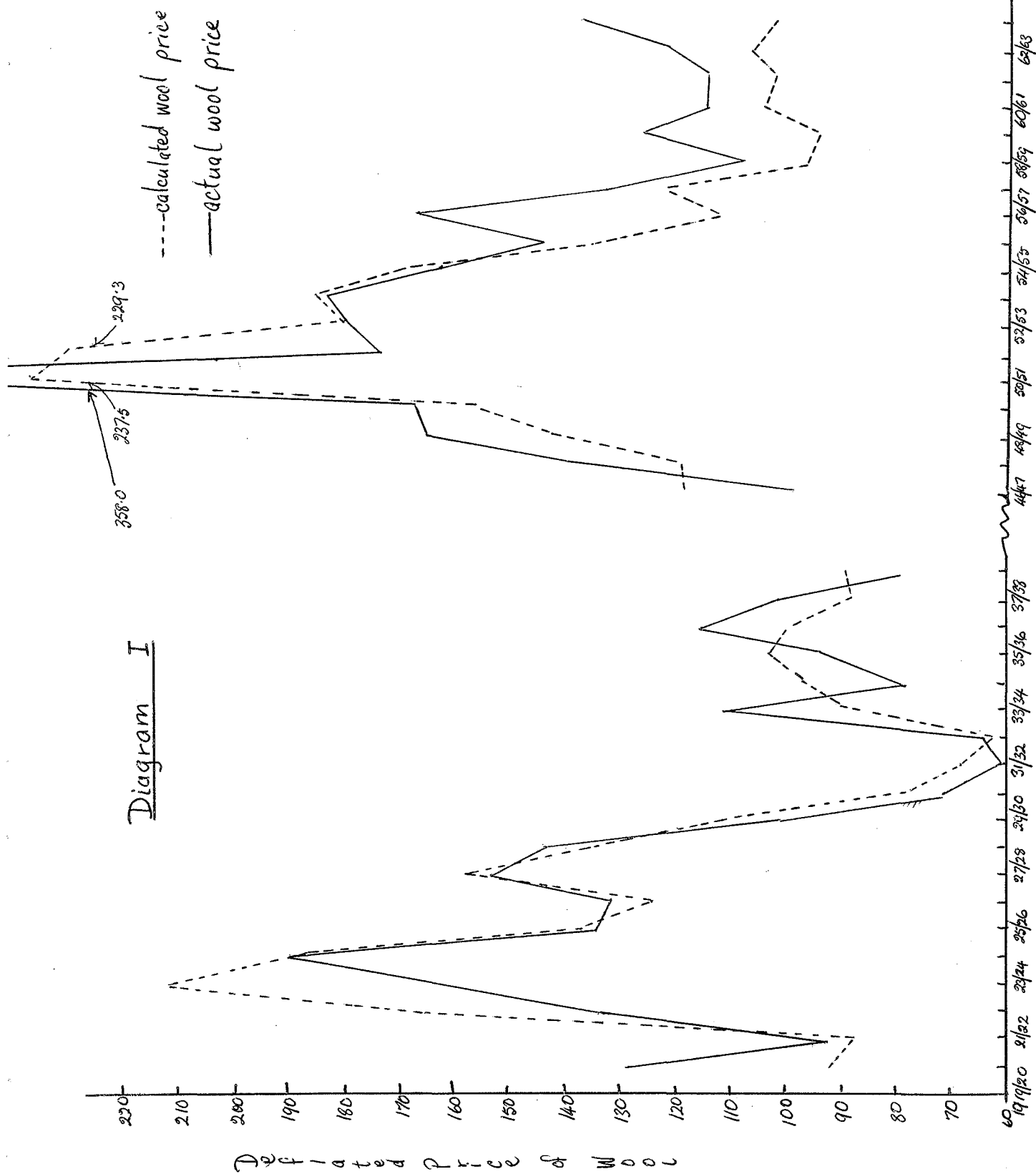
Such a comparison is given in Diagram I.<sup>1</sup> In effect Diagram I compares that price (in relation to all other prices) at which all the current season's wool clip would be absorbed by final consumers of clothing, given their real income, with the average price at which the market settles under the influence of the forces analysed in the short period model. By and large these two prices move in the same direction as shown by Diagram I, but there is nevertheless clear evidence<sup>2</sup> that, season by season, the market price oscillates around the annual long period equilibrium price and that this oscillation became quite violent in the period 1950 to 1953.

With these general notions on price fluctuation in mind we may now look at three specific instances where they can be applied; space permits us only to do this very sketchily. Firstly, there was the severe depression in wool prices experienced in the 1890's. This was fairly certainly due to an increase in the rate of growth of supply relatively to income, no doubt a result of the opening up of new land in the 70's and 80's in Australia and New Zealand. Now there is nothing inherently wrong with low prices as such provided that at those prices the actual quantity supplied is the same as the planned quantity supplied, i.e. a situation, as we have defined it, of very

<sup>1</sup> Diagram I has been drawn on the basis of the long period regression recalculated on data up to 1964 as given in Part II of this Paper.

<sup>2</sup> The same conclusion could be reached rather more laboriously by linking, in the form of difference equations, the short period model with the long period model and assessing the nature of fluctuation in terms of the coefficients of wool consumption and wool supply from the short period regressions. Such an analysis suggests that a damped endogenous short period cycle could be expected.

Diagram I



long period equilibrium. The very great economic distress occasioned in Australia and New Zealand by these low prices in the 90's seems to indicate that with these low prices the wool industry was far from being in very long run equilibrium and the fall in supply which subsequently occurred and which raised wool prices was something we would expect and welcome.

In contrast to this consider the situation in the 1930's. The fall in wool prices in this period was in no sense a result of "overproduction" as in the 90's, but was a result of the cyclical dip in world income. However, it had the same result as the slump in the 90's. Though no great absolute fall was subsequently registered in wool production, the rate of increase declined relative to the rate of increase in world income. The present continuing boom in wool prices is in part a result of this decline in supply attributable ultimately to the 1930 slump. We cannot, without possessing some knowledge of supply elasticities, suggest much about the future but the present high prices are bound to quicken the rate of increase of production and some decline in prices in the future should perhaps be expected.

Thus there are grounds for believing that the long period cycles in wool prices can be explained in terms of differences in the rate of growth of supply and income, and of the "cobweb" movements to which such differences eventually give rise.

Now consider the case of short period fluctuation, exemplified by events from 1950 to date. Mention was made above of the fact that post-war wool production was running



at a figure not greatly in excess of pre-war in relation to the rise in world income over the period. However, for the years 1946 to 1950 production was supplemented by the very large disposals of United Kingdom Wool Disposals Ltd.,<sup>1</sup> the organisation set up to liquidate the stockpile of wool accumulated over the war years. By June, 1950, this wool had virtually all been sold, so that a fall in supply of approximately 15% became inevitable, necessitating the rise in long period equilibrium price shown in Diagram I. Wool consumption was running at very high levels in 1950 (in part a result of the cheap wool available in previous years) and considerable increases in price were expected at the opening of the 1950-51 season. Such expected increases, however, were small in comparison with the additional rise induced by the outbreak of the Korean war, which produced a sharp upward shift in expectations about future raw material prices in general and about future wool prices in particular. It is possible that this enormous rise in wool prices was instrumental in producing the wool textile slump of 1951-52 when the prices were passed on to consumers. That the fluctuations since 1950 are part of a "cobweb" movement initiated by the shock administered to prices in that year cannot, of course, be stated with confidence in the present state of knowledge, but the possibility is an interesting one.

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<sup>1</sup> Usually known as the "Joint Organisation".

#### VIII. IMPLICATIONS FOR ECONOMIC POLICY IN WOOL-GROWING COUNTRIES

The analysis which has been set out above and applied tentatively to particular historical episodes may now be used as the basis for some brief general remarks about policy.

If the real price of wool has fallen as a result of a greater increase in supply than that warranted (according to the very long period equation) by the increase in world income, so that wool growing is now no longer profitable, then a wool-growing country may usefully devalue its currency, or deflate its price level or industrialise, or do all of these things. In this way imports of manufactures are replaced by domestic production and the expansion of wool production checked or even reversed. The fall in wool production in the years after 1895 was probably a result of such an economic policy in Australasia and in view of the facts, the policy was justified. A rise in real wool prices greater than that warranted by the size of world income justifies a reverse policy.

On the other hand, if the fall (or rise) in prices is the result of a cyclic movement in world income, lasting for say three years, then there is no justification for a substantial outflow (or inflow) of resources from (or into) the wool producing industry. Such policies as industrialisation, designed for this purpose, will probably, in the long run, return less in terms of real income than policies designed to maintain wool production pending the eventual rise in world real income. In these cyclical cases (assuming that when they occur they can be identified as

such) the appropriate measures consist of the formation of world wide or national buffer stocks, or, if these are not feasible, of other national measures to maintain production.<sup>1</sup> As it was, the wool slump of the 1930's resulted in the same policy as the slump of the 1890's, without the same justification.

Such a buffer stock would contribute towards the optimum long run allocation of resources (at least as far as sheep farming is concerned), but it would also help to eliminate those violent short period movements which mark the transition from one long period equilibrium price to another, such as occurred in 1950-51.

The Joint Organisation, which had the stocks adequate for such an enterprise, was set up with the aim of disposing of the wool stockpile as quickly as possible without unduly disturbing the current wool market. As this had the effect of keeping down the price, and therefore of raising consumption above the long period equilibrium level and of lowering the rate of increase of production, the seeds of part of the 1950-51 boom were inevitably being sown. By disposing of the clip at a slower rate and allowing the price to rise slowly this would have been avoided.

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<sup>1</sup> If international buffer stocks are not feasible but national buffer stocks are feasible, it may be necessary for the individual countries running them to supplement the policy with measures aimed at maintaining balance of payments equilibrium. This in the absence of devaluation may necessitate trade controls but considered as necessary adjuncts to a policy of maintaining wool production these would be less odious than as methods of encouraging local manufacturing.

While it is true that these conclusions are easy to reach after the events, it is also true that, in coping with similar situations in the future, the policy of a government or of a wool marketing body will be the better informed if it is based upon some such analysis as has been attempted here.

TABLE III

STATISTICAL DATA USED IN LONG PERIOD REGRESSION NO.10  
(TABLE I)

1934-38 = 100

5-year moving averages centred on year shown

Year	(1) Deflated wool prices	(2) Supply of wool	(3) Index of industrial product- ion	(4) Cotton prices ÷ cost of living
1920	-	-	-	-
1921	-	-	-	-
1922	149.7	86.9	68.4	174.6
1923	140.3	88.8	72.0	166.8
1924	141.4	88.3	77.9	172.2
1925	149.3	86.1	82.4	167.0
1926	153.3	86.5	87.0	154.1
1927	150.1	89.8	92.1	140.8
1928	132.6	93.7	93.5	129.4
1929	120.1	96.4	91.7	120.5
1930	106.0	97.9	86.5	110.8
1931	88.3	100.3	82.4	98.4
1932	82.0	100.9	78.4	92.6
1933	77.2	100.6	79.0	92.5
1934	81.8	100.6	84.4	98.5
1935	92.6	100.7	94.1	102.4
1936	100.0	100.0	99.9	100.2
1937	93.5	100.6	104.1	95.7
1938	-	-	-	-
1939	-	-	-	-
1946	-	-	-	-
1947	-	-	-	-
1948	132.6	136.6	148.2	-
1949	184.6	128.5	160.5	213.1
1950	199.8	125.2	170.8	219.9
1951	207.9	121.4	181.6	216.8
1952	211.9	120.4	192.2	213.6
1953	210.8	119.0	203.3	201.5
1954	167.7	122.3	213.5	174.8
1955	166.2	129.2	224.4	157.0

TABLE III (Cont'd)

1956	157.0	133.4	231.4	146.9
1957	142.0	138.3	243.2	131.9
1958	135.0	144.1	254.4	118.0
1959	129.2	147.9	265.4	112.7
1960	118.7	149.7	278.6	108.9
1961	116.2	152.7	296.3	105.8
1962	121.8	155.0	311.9	104.9
1963	-	-	-	-
1964	-	-	-	-

- <sup>1</sup> Seasonal weighted average of 64's and 50's from "Wool Intelligence", C.E.C. divided by simple average of cost of living indices (in sterling) of United Kingdom and U.S.A.
- <sup>2</sup> Production in nine main growing countries plus sales ex B.A.W.R.A. and J.O.
- <sup>3</sup> From W.A. Lewis "World Production, Prices and Trade", Manchester School, 1952, and U.N. Year Books.
- <sup>4</sup> Sterling cotton prices from U.K. "Abstract of Statistics".

TABLE IV

DATA USED IN SHORT PERIOD REGRESSION NO. 7 (TABLE II)  
(and as revised in Part II)

1934-38=100

Wool selling season July-June	Wool prices (seasonal <sub>1</sub> average).	Wool textile activity <sub>2</sub> (seasonal).	Wool supply including stocks in U.K. and U.S.A. at Dec.mid <sub>3</sub> season.	Other raw material prices <sub>4</sub> (seasonal)
1920-21	202.6	81.2	95.2	241.8
1921-22	117.5	93.6	114.8	163.8
1922-23	163.9	105.4	107.2	153.6
1923-24	199.5	103.2	95.4	155.7
1924-25	230.4	100.1	86.9	165.2
1925-26	162.4	98.9	96.6	152.0
1926-27	155.7	101.9	95.5	158.5
1927-28	179.4	103.1	89.4	143.7
1928-29	167.0	100.0	90.6	137.7
1929-30	110.3	93.0	90.5	125.0
1930-31	75.8	85.1	96.3	102.6
1931-32	64.4	82.6	100.5	96.3
1932-33	65.5	89.3	110.9	92.4
1933-34	106.7	93.1	101.1	95.1
1934-35	76.3	96.0	104.1	97.4
1935-36	93.8	103.8	99.4	100.6
1936-37	119.1	108.0	100.3	114.9
1937-38	105.1	100.7	95.0	114.5
1947-48	275.8	101.8	132.3	287.7
1948-49	330.9	107.2	114.6	310.7
1949-50	413.9	115.0	132.1	344.3
1950-51	958.8	117.9	103.1	564.0
1951-52	485.6	97.3	97.7	546.0
1952-53	517.0	114.7	120.9	474.0
1953-54	540.2	114.6	111.7	445.0
1954-55	480.1	116.2	110.2	458.0
1955-56	435.3	124.7	124.0	483.0
1956-57	527.3	132.3	127.9	494.0
1957-58	429.4	122.1	117.1	469.0
1958-59	353.2	126.0	135.4	464.0
1959-60	417.9	140.8	133.1	469.0
1960-61	385.6	135.1	136.9	463.0
1961-62	395.5	141.5	136.3	461.0
1962-63	420.4	143.7	134.7	463.0
1963-64	488.6	145.8	129.7	482.0

TABLE IV (footnotes)

- <sup>1</sup> Weighted average of London clean price of 64's and 50's; weights in proportion to quantities of Merino and Cross-bred sold by nine main producers.
- <sup>2</sup> 1920-21 to 1937-38 : Two year average of Index of Wool Textile Activity from "Wool Prices". 1937-38 to 1952-53 Seasonal wool consumption from "Wool Intelligence" C.E.C.
- <sup>3</sup> Wool production in nine leading producers plus changes in producers' carry-over, plus sales from B.A.W.R.A. and J.O. stocks, plus trade stocks in U.K. and U.S.A. at December 31 (mid-season). Basic series from "Wool Prices".
- <sup>4</sup> To 1949-50 Sauerbeck Index on seasonal basis. 1950-51 to 1952-53 U.K. wholesale Price Index (raw materials component).



## PART II

POSTSCRIPT - THE REGRESSION EQUATIONS  
BROUGHT UP-TO-DATE

The text of Part I was written in 1954. Since then a lot more research work has been completed on econometric models of the wool market at the Agricultural Economics Research Unit, incorporating various improvements and refinements, some of which are detailed below. The results of this research will be the subject of a series of forthcoming Research Unit publications and it is not our purpose to discuss them here. In this postscript we simply aim to present the results of recomputing, with the additional ten years' data now available to us, some of the regression equations given in Part I.

The long run regression No.10, given in Table I, has been recomputed with the addition of observations for the years 1954 to 1964. The new regression equation is as follows:

$$Y = 0.59 X_1 - 0.94 X_2 + 0.87 X_3 + 0.98 \quad R^2 = 0.98$$

(0.15)      (0.14)      (0.04)

where

Y is : Deflated Price of wool (weighted average of quotations for 64's and 50's)

X<sub>1</sub> is : Index of world industrial production

X<sub>2</sub> is : Index of supplies of wool

X<sub>3</sub> is : Deflated price of cotton

All variables expressed as logarithms of 5 year moving averages of index numbers on base 1934/38=100.

Diagram II gives a visual indication of the extent to which this equation explains the long term movements in prices which have occurred since 1920. In this diagram we compare the prices predicted by the equation with those which actually prevailed.

Short run regression No.7, given in Table II, has also been recomputed using additional observations for 1953/54 to 1963/64 giving the following amended equation:

$$Y = 1.19 X_1 - 1.54 X_2 + 1.08 X_3 + 1.20 \quad R^2 = 0.96$$

(.30)      (.28)      (.06)

where Y is : Index of price of wool

$X_1$  is : Index of Seasonal wool textile activity

$X_2$  is : Index of wool supply including begin season  
commercial stocks in U.K. and U.S.A.

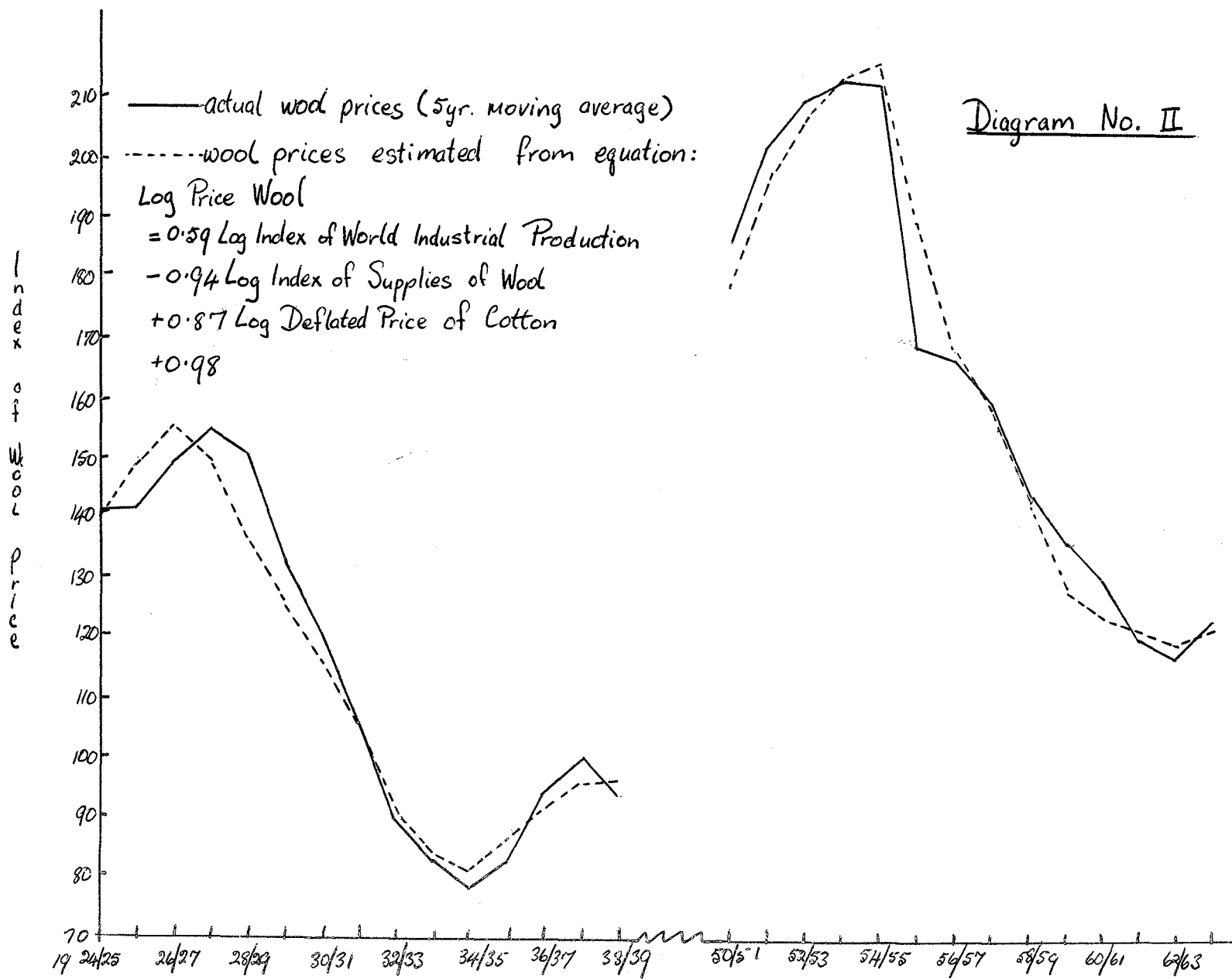
$X_3$  is : Index of general raw material prices

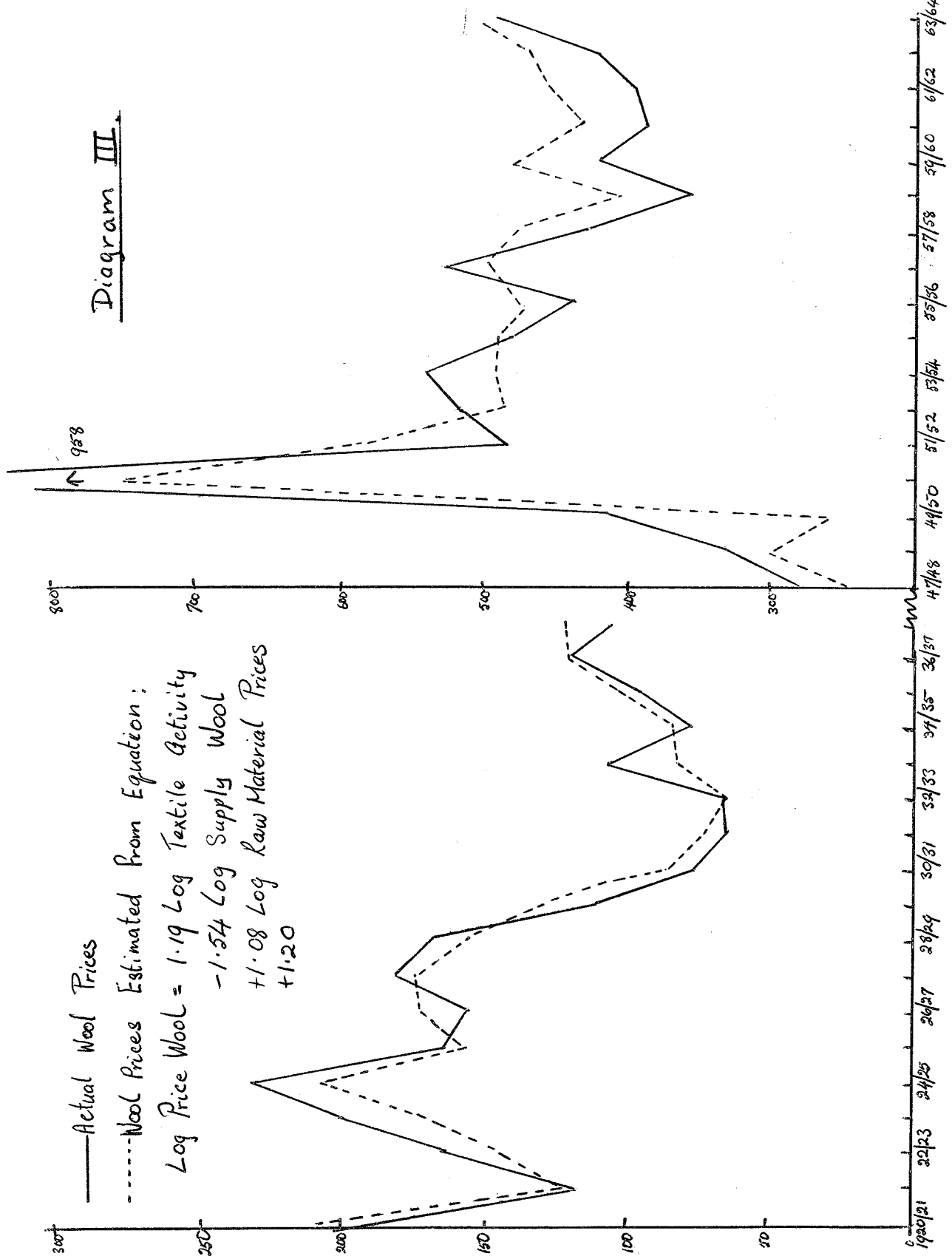
All variables expressed as logarithms of index numbers on base 1934/38=100.

Diagram III compares the actual value of wool prices with the values predicted by the equation.

It is not our purpose to give an extended discussion of the results presented in Diagrams II and III, since they are simply presented here to bring up-to-date the work described in Part I. We can conclude however with a list of some of the more obvious improvements which are required in the analyses as presented, either by the addition of further variables, or by complete respecification of the model.

As far as the long run analysis is concerned, the following amendments should clearly be considered:





- (a) Allowance for the introduction of wool type synthetic fibres since the 1950's.
- (b) Allowance for population changes by expressing the variables on a per capita basis.
- (c) The separate explanation of Merino and Crossbred wool prices.
- (d) The use of better estimates of real income in consuming countries in place of the index of industrial production, and explicit allowance for the fact that there are many small countries which consume, usually by way of imports, small quantities of wool textiles and so exert an influence on the market.
- (e) Lastly, there are serious statistical disadvantages implicit in the use of moving averages and the model should be rephrased to avoid the need to test it in this form.

As for the short run model the following improvements are required:

- (a) An explanation must be provided for the break in the market which appeared about 1958 showing itself in Diagram III by actual prices running consistently below those predicted by the equation.<sup>1</sup>
- (b) The model should be reformulated and data assembled to explain, if possible, fluctuations in prices quarterly or even monthly.

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<sup>1</sup> A similar break in the market is noted by Polasek, Ferguson and Burley in "U.S.A. Import Demand for Apparel Wool", *Econometrica*, Vol.30, No.4, October 1962.

- (c) The specific influence on prices of stock changes should be estimated as distinct from the method adopted in Short Run Equation 7 above, of including stocks with supplies of wool.

These, and other adjustments and amendments, have been explored in research work subsequent to that reported in this bulletin and the results of these refinements will be reported in a series of forthcoming bulletins for which the present paper represents an introduction.

*Lincoln College*

AGRICULTURAL ECONOMICS RESEARCH UNIT



PUBLICATIONS

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1. *The Systematic Evaluation of Development Projects*, J. T. Ward
2. *The New Agricultural Economics Research Unit*, B. P. Philpott
3. *Indicative Planning for the Poultry Industry in New Zealand*, J. T. Ward
4. *The International Sugar Situation and New Zealand's Sugar Policy*, A. R. Frampton
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